

REMARKS

In response to the Official Action mailed December 13, 2002, Applicant amends his application and requests reconsideration. In this Amendment, non-elected claims 11 and 12 are cancelled and claim 13 is added so that claims 1-10 and 13 are now pending.

New claim 13 is clearly supported by the application as filed. For example, see Figure 1 and its description.

The Examiner erroneously stated that the response to the species election requirement was made without traverse. The Examiner's attention is invited to page 2 of the response and the final paragraph of the response. That paragraph made unequivocally clear that the election was made with traverse if the Examiner erroneously demanded an indication as to whether the election was made with or without traverse. Moreover, the Examiner has now correctly recognized that claim 1 is a generic claim. Upon allowance of that generic claim 1, Applicant intends to require rejoinder to the prosecution of this application claims 6-10 pursuant to 37 CFR 1.141, not cited by the Examiner in the species election requirement.

The Examiner requested a more descriptive title and a substitute title is supplied.

In this Amendment, claim 1 is clarified. Claims 2-9 are also amended to be consistent with the clarified form of claim 1. Amended claim 1 is easily understood in reference to the embodiment of the invention illustrated in Figures 1 and 2 of the patent application. The device illustrated there includes a substrate 6 supporting an insulating layer 1. The insulating layer includes a number of interconnection grooves, including a relatively wide interconnection groove 5, also illustrated in Figure 2 in a perspective view, and narrower grooves 5 at the left half of Figure 1. Each of the interconnection grooves includes side surfaces 2a. In addition, each interconnection groove includes a bottom surface. The widest interconnection groove in the embodiment of Figure 1 includes recesses extending from the bottom surface of the groove into and within the insulating layer 1. As shown in Figure 2, the shape of those recesses in the embodiment of Figure 2 is the shape of a groove. The embodiment of Figure 3 includes recesses that are circular in cross-section and referred to as "holes" in the patent application. The embodiment of Figure 4 shows recesses having a groove-shape with a triangular cross-section rather than the rectangular cross-section of the recesses of the embodiment of Figure 2. Figure 6 illustrates an embodiment in which the recesses are holes with a conical shape, having a generally circular part where the recesses intersect the bottom surface of the groove and tapering to respective points. Still other embodiments of recesses are illustrated in Figures 8, 9, and 12 of the patent application.

The recesses extending deeper into the insulating layer than the interconnection groove are important in the plating process in which the interconnection groove is filled with a

conductive layer, for example, copper. This importance is repeatedly described in the patent application. The first such explanation appears at pages 10 and 11. It is pointed out at those two pages that the presence of the recesses, referred to as "unevenness" in the patent application, has an extraordinarily beneficial effect of reducing a step difference, i.e., the maximum difference in thickness, of the metal deposited in the interconnection grooves of different widths or of different aspect ratios. The recesses increase the plating rate by controlling the internal distribution within a plating solution of important ingredients. As a result, wide and narrow interconnection grooves can be more uniformly filled with a metal in the claimed structure than in similar varying width interconnection grooves without recesses.

Through inadvertent error, claims 2-7 were improperly amended in the Preliminary Amendment. The original meanings of those claims are restored here to ensure that each claim is supported by the original disclosure.

~~1~~ Claim 1 was rejected as anticipated by Jeong (U.S. Patent 5,960,317). This rejection is respectfully traversed.

Plainly, the rejection for anticipation cannot be maintained. While Jeong depicts a semiconductor device including a substrate supporting an insulating film containing metal filled grooves, all of the grooves, wide and narrow, make contact to respective wiring layers 25, 55, and 75. The metal contact is essential to the function of Jeong's contacts. Unlike the interconnection grooves of claim 1, Jeong's grooves cannot be and are not confined within an insulating layer. Jeong cannot anticipate claim 1 because Jeong lacks important structure described in amended claim 1. Jeong cannot even suggest claim 1 because Jeong provides no reason for supplying a plurality of recesses extending from a groove filled with an electrically conductive material and contained entirely within an insulating layer.

Claims 2-5 were rejected as unpatentable over Jeong in view of Jeng et al. (U.S. Patent 5,893,734, hereinafter Jeng). This rejection is respectfully traversed.

The first ground upon which the rejection of claims 2-5 is traversed is the failure of Jeong to anticipate claim 1. That anticipation is essential to the rejection for obviousness of claims 2-5. Since the rejection for anticipation of claim 1 cannot properly be maintained, the rejection of claims 2-5 fails with the failure of the rejection of claim 1.

Claims 2-5 were rejected upon the assertion that the aspect ratios described in those claims are optimizations based upon the disclosure of Jeng. The reasoning for this rejection is erroneous on two separate grounds. First, the optimization referred to in Jeng pertains to making electrical contacts, not to filling interconnection grooves with a metal so that interconnection grooves of different widths are essentially uniformly filled. Thus, the optimization of Jeng is irrelevant to the particular aspect ratios of claims 2-4, aspect ratios that are described in the

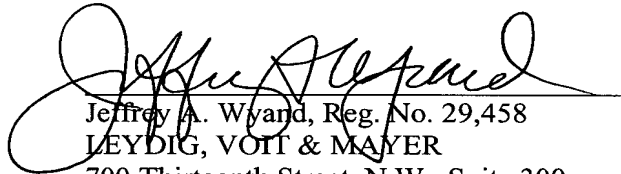
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Application No. 09/892,603

patent application as important and relating to achieving the desired uniform filling of wide and narrow grooves.

In addition, the patent application discloses the importance of the aspect ratios mentioned in claims 2-5 in achieving the desired result of the invention, the improved uniformity of the filling of interconnection grooves with electrically conductive materials, i.e., metals. These aspect ratios are more akin to critical relationships than optimizations and, for this second reason, clearly distinguish over Jeng, even if Jeong were to anticipate claim 1.

For the foregoing reasons, all of claims 1-5 are plainly patentable over Jeong considered alone or in combination with Jeng. Thus, those claims should be promptly allowed. Further, pursuant to 37 CFR 1.141, Applicant now requests that claims 6-10 be rejoined to the prosecution and also allowed since claim 1 is a generic claim. Claims 6-10 have been amended to conform to amended claim 1 for prompt allowance.

Respectfully submitted,


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PATENT
Attorney Docket No. 401265/FUKAMI

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

YOSHIHIKO TOYODA

Application No. 09/892,603

Art Unit: 2826

Filed: June 28, 2001

Examiner: L. Andujar

For: SEMICONDUCTOR DEVICE

AMENDMENTS TO CLAIMS MADE IN RESPONSE
TO OFFICE ACTION DATED DECEMBER 13, 2002

Amendments to existing claims:

Cancel claims 11 and 12.

1. (Twice Amended) A semiconductor device comprising:

an insulating layer having ~~a~~ an outside surface and including a plurality of grooves having different widths, each of the grooves including side surfaces and a bottom surface, at least one of the grooves including a plurality of recesses extending entirely within the insulating layer, from the bottom surface of the groove, and into the insulating layer; and

a conductive layer filling each of the grooves and the recesses, the conductive layer including at least a plated layer, wherein a bottom portion of some of the grooves is non-planar covering the side surfaces and the bottom surfaces of the grooves and internal surfaces of the recesses.

2. (Twice Amended) The semiconductor device according to claim 1, wherein the ~~non-planar bottom portions have~~ groove including the recesses has a ratio of depth to width of not more than 0.7.

3. (Twice Amended) The semiconductor device according to claim 1, wherein the ~~non-planar bottom portions have~~ groove including the recesses has a ratio of depth to width of not more than 0.35.

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4. (Twice Amended) The semiconductor device according to claim 1, wherein the ~~non-planar bottom portions include a concave portion having~~ recesses have a groove shape, with a ratio of depth to width greater than 0.35.

5. (Twice Amended) The semiconductor device according to claim 1, wherein the ~~non-planar bottom portions include a concave portion having~~ recesses have a groove shape, with a ratio of depth to width greater than 0.7.

6. (Twice Amended) The semiconductor device according to claim 1, wherein the ~~non-planar bottom portions include a concave portion having~~ recesses have a hole shape, with a ratio of depth to width greater than 0.35.

7. (Twice Amended) The semiconductor device according to claim 1, wherein the ~~non-planar bottom portions include a concave portion having~~ recesses have a hole shape, with a ratio of depth to width greater than 0.7.

8. (Twice Amended) The semiconductor device according to claim 1, wherein the ~~non-planar bottom portion has a concave portion having~~ recesses have two slanting side faces intersecting each other in a cross-sectional view.

9. (Twice Amended) The semiconductor device according to claim 8, wherein the side faces are slanted with an angle greater than 20 degrees relative to the surface of ~~said~~ the insulating layer.

10. (Twice Amended) The semiconductor device according to claim 1, wherein the ~~non-planar bottom portions of the grooves~~ recesses have ~~concave portions with~~ a pitch not more than 4 times a width of the ~~concave portions~~ recesses.